

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1591

TRANSPLANTING TREES AND SHRUBS



TRANSPLANTING trees and shrubs is a means of quickly transforming natural desolation and that brought about by human operations into attractive scenes. It is also a means of making possible the more economical production of food crops.

Essentials for successful transplanting are—

A good plant, including a well-developed root system and a healthy top.

Moving at the proper season: Deciduous plants while dormant; evergreens when the ground is sufficiently warm and moist to stimulate the plant to the immediate formation of roots.

Proper digging: Dormant deciduous plants to be dug with a minimum of injury to the roots, but without soil; evergreens with a ball of earth about the roots.

Well-protected roots; that is, kept covered and moist, and the ball, if any, unbroken.

An adequate hole, wider and deeper than the spread of the roots.

Proper setting: Set at the depth at which it formerly grew, with the roots well spread.

Suitable soil as to moisture, texture, and fertility.

Correct planting: The soil to be brought into close contact with the roots.

Top pruning, to balance the loss of roots or other injury.

Maintenance of adequate soil moisture until the plant is reestablished.

Various methods of handling are employed with different types and sizes of plants, in order the better to meet these requirements under varying soil conditions. Mechanical helps, such as derricks, pulleys, and jacks, are advisable for large plants.

TRANSPLANTING TREES AND SHRUBS

By FURMAN LLOYD MULFORD, *Associate Horticulturist, Office of Horticultural Crops and Diseases, Bureau of Plant Industry*

CONTENTS

	Page		Page
Introduction.....	1	Transplanting essentials—Continued.	
Transplanting.....	2	Suitable soil.....	13
Preparation of plants for transplanting.....	2	Proper setting.....	14
Size of plants for planting.....	4	Correct planting.....	14
Kinds of plants for planting.....	5	Pruning.....	18
Transplanting essentials.....	6	Watering.....	19
Good plants.....	6	Handling large trees.....	21
Right season for transplanting.....	6	Handling ornamental trees without a ball.....	22
Good digging.....	8	Handling ornamental trees with a ball.....	24
Root protection.....	9	Transplanting large orchard trees.....	29
Preparation of the hole.....	11		

INTRODUCTION

MAN in developing his civilization destroys many of the natural beauties found before his coming. In the regions of his greatest activity there is the greatest destruction. This is done to make room for his farms, roads, railroads, villages, towns, and cities. In spite of his excessive destruction of natural growths, he loves shade and growing plants and will make a great effort to gather trees and shrubs where he can enjoy them in his daily life as a partial substitute for what he has destroyed. He also needs them to supply fruits and various products contributed by forests.

In order that the benefits accruing to primitive man from his association with these things shall not be lost to people of the present day, it is necessary painstakingly to substitute plants for those that have been destroyed. To do this, plants must be moved from one place to another continually; building sites need to be made beautiful; severe street lines require softening; parks are to be developed; country roads require shade; orchards and small-fruit plantations are to be established; forests must be reestablished, and plants must be prepared to satisfy such demands.

This moving of selected plants from one location and placing them in another with the intention of having them continue their growth is called transplanting. When it is ideally done, a plant with all its roots intact is lifted without in the least loosening its contact with the soil and then is placed in a new location suitable for its continued growth. Fortunately, most of the plants that man uses can be handled with more or less variation from these ideal conditions, many of the common plants being carelessly treated in comparison with those that are hard to move.

In the following pages an effort is made to present the essential factors for successfully moving trees and shrubs, without attempting

to discuss conditions for continued success in their cultivation, their arrangement in garden, orchard, windbreak, forest plantation, or landscape,¹ or the climatic range of their probable successful cultivation after being moved.

TRANSPLANTING

Transplanting consists of three rather distinct operations—digging, transporting to the new location, and planting. In general, the home owner, gardener, and orchardist takes an active part only in the planting. Usually he obtains a tree or a shrub to place in its permanent location and so is interested in the plant only after it has been properly grown and delivered to him in such condition that it may be expected to thrive in the new place. It is important that the previous operations shall have been well done, but he especially needs information on the details of planting. Those, however, who are preparing trees and shrubs for later use frequently have to transplant them.

PREPARATION OF PLANTS FOR TRANSPLANTING

Seeds may be sown thickly in prepared seed beds or flats where the best of care may be given while the seed is germinating and while the seedlings are young, but the young plants soon must be moved so that they will have space to develop. Cuttings are placed closely in special beds while rooting, after which better soil and more room are needed. Sometimes young seedlings or cuttings may be moved directly into their permanent place in the garden, or field, but more often they are transferred to pots, flats, frames, or special beds, where continued attention is given until they are sufficiently well developed to be placed in their permanent location. Then again they must be protected from frost or from too strong sunshine or they may require special watering so that the roots or even the air about the tops may not become too dry. Transplanting to a temporary location is often economical, as the plants may be grown close together and be so placed as to facilitate cultivation. They should also be so grown as to encourage adequate root and top growth, so that when permanently placed the plant will be prepared to flourish and give the desired results.

The determining factors for good plant growth are a soil suitable for the production of a good root system, sufficient space for the development of a healthy, symmetrical top, and an arrangement that easily permits the soil about them to be kept free from weeds. Nearly a century and a quarter ago Bernard McMahon² wrote:

Reason teaches that young trees growing vigorously and freely in a good soil will form numerous and healthy roots, and when they come to be afterwards planted in worse land, they will be able, from the strength of their constitution, and multiplicity of roots, to feed themselves freely with coarser food. On the contrary, young trees raised upon poor land, by having their vessels contracted, and their outward bark mossy and diseased, will be a long time, even after being removed into a rich soil, before they attain to a vigorous state. If the roots of the young plants have not a good soil, or sufficient room to strike in,

¹ Further information on the handling of particular types or kinds of plants will be found in other Farmers' Bulletins of the United States Department of Agriculture.

² MCMAHON, B. AMERICAN GARDENER'S CALENDAR. P. 43. Philadelphia. 1806.

there will be little hope of their furnishing themselves with that ample stock of roots and fibers, which is necessary to a good plant, and, with which every young tree ought to be well furnished, when removed for final transplantation.

These suggestions apply especially in nurseries (fig. 1), where plants are prepared to give quick results when permanently planted.

Root pruning is essential at least every second year that a plant remains in the nursery in order that the root system may be made compact, thus putting it in good condition for planting in its permanent location. The roots should be cut a short distance from the crown to cause them to branch freely. This is done by running a tree digger under the plant; or, in a small way, by pushing a spade into the soil about it so that all roots that extend beyond a prescribed distance are severed; or by transplanting, which is usually required every second time root pruning is done. Plants kept in the nursery

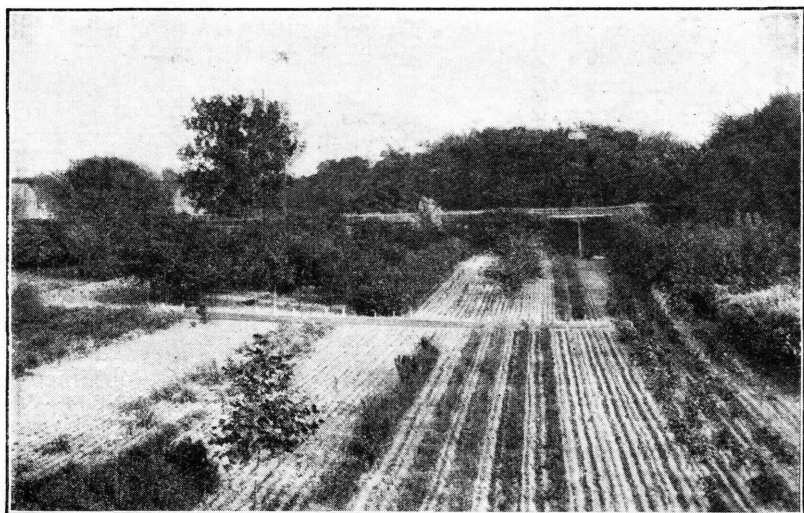


FIGURE 1.—A nursery where plants have been transplanted in a way that facilitates the effective control of weeds, thus permitting the full development of the plant for future use

until they are large are often root pruned by digging trenches about them, the trench being refilled with good soil.

Plants grown for several years in one place without root pruning are usually not in condition to be successfully transplanted. Their roots are relatively few and unbranched and have grown long distances to obtain needed food and moisture. In order to have the compact and much-branched root system that is desirable for successful transplanting, a system of root pruning known as trenching is recommended. To cut off the ends of long roots by digging encourages the growth of new roots by the branching of the portions that remain. By cutting off the roots the top growth is checked, and new roots are encouraged to grow near the base of the plant where they may be taken along instead of being severed and left behind at moving time.

Trenching therefore consists in digging a ditch about the plant and severing all the roots at an appropriate distance from the crown or trunk. The volume of soil inside the trench, commonly referred to as

the ball, varies with the size of the tree or shrub, from a few inches to 20 feet across and from 6 inches to 3 feet deep. When transplanting time comes the ball is usually moved with the plant. In the case of a large tree (fig. 2) this trench is not dug all in one season, as that would sever too many of the feeding roots at one time. Thus segments A, C, and E may be dug one year, leaving B, D, and F to be dug the following year. It is better, however, to dig segments A and D one year, B and E the next, and C and F the third year.

The trench should be refilled with topsoil and manure to encourage the formation of new feeding roots, and the plant should not be

moved until a year after the last portion of the trench has been filled. Roots on the side next to the tree should be left with a clean smooth cut, and they should be covered promptly with good soil so that new root growth may take place as quickly as possible. With most deciduous trees it is not necessary that the ball of earth be moved, although better results are usually obtained if the contact of the roots with the soil is unbroken. If the earth is not taken, all the roots within it, including the new ones formed in the trench, should be retained uninjured.

With evergreens,

however, the ball left when the trench is dug, together with the new roots formed in the trench, must be included in the ball that is moved.

SIZE OF PLANTS FOR PLANTING

Plants taken from a nursery are generally small enough for one man to move easily, but better and more economical planting can be done by two men working together. Occasionally larger ornamental plants, even those nearly mature, are taken to give as finished an appearance as possible to the plantation. As a rule, medium-sized plants are easier to transplant and become established more quickly than larger ones.

The sizes of various types of plants most frequently used are as follows: Ornamental evergreens, both broadleaf and deciduous, 3 feet high; deciduous street and ornamental trees, 5 to 10 feet high and of

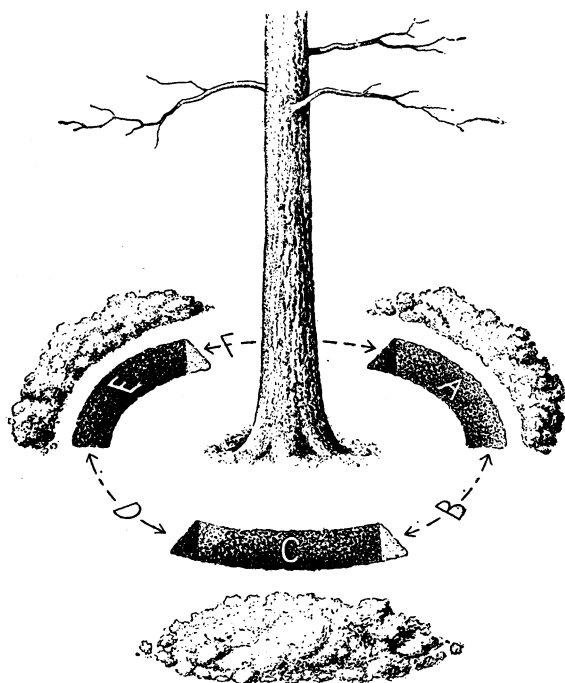


FIGURE 2.—Root pruning a large tree by the trenching method preparatory to transplanting

less than 3 inches trunk diameter; deciduous ornamental shrubs, 3 to 4 feet high, with several branches; orchard trees, 4 to 6 feet high; berry plants, 2 to 5 feet high; trees for forestry and windbreak planting, from 6 to 24 inches high; and plants for lining out in the nursery, from 3 to 4 inches high, taken from seed beds or cutting beds, to the sizes just mentioned for the various purposes.

If, however, a finished appearance is desired at once, very large plants must be used. In such cases transplanting is frequently a severe ordeal, as many roots are necessarily severed and the tops must be correspondingly pruned. Such plants require much more exacting and expensive care than do smaller plants. The high initial cost and subsequent care is often warranted, however, for in many parts of the country the plants will become so well reestablished that they will live for a long time.

KINDS OF PLANTS FOR PLANTING

The kinds of plants to use in any planting are determined by the soil, exposure, elevation, and climate of the region.

Woody plants may be divided into two main groups—deciduous and evergreen. Deciduous plants are those whose leaves die on the approach of cold weather; they grow practically everywhere and constitute the principal plant growth in most parts of the country. Evergreens are those holding their leaves during the winter or until after one or two new crops of leaves have grown, thus affording an abundance of green foliage throughout the year. Often these leaves take the form of slender needles or close scales, as, for example, in the cone-bearing trees that we call coniferous evergreens, such as pines, firs, and cedars. In contrast there are those that have leaves with a broad blade, spoken of as broadleaf evergreens, such as American holly, southern magnolia, mountain laurel, rhododendrons, and gums or eucalypts. Comparatively few evergreens can be successfully grown in the dry parts of the central and western United States (fig. 3), especially where unprotected by buildings or other trees, owing to the excessive evaporation caused by dry winds. There are some kinds, however, that may be grown even under these severe conditions. Primarily, evergreens are plants of moist climates, the cone-bearing trees being best adapted to the North and the broadleaf ones to the South, although many, as the gums or eucalypts and the palms, thrive in dry, hot regions.

Coniferous or cone-bearing evergreens, called in their native habitats "evergreens," are at home in greatest variety in the northeastern United States, the Puget Sound region, and southward in the mountain ranges. Broadleaf evergreens have one type adapted to the Southeastern States and the humid portions of the Pacific coast, whereas another type is adapted to the warm, dry atmosphere of the interior of California.

Because of the demand of the foliage for a continuous and abundant supply of moisture on the part of evergreens, both broadleaf and coniferous, the care required in moving them is greater than in moving deciduous plants.

TRANSPLANTING ESSENTIALS

GOOD PLANTS

A good, vigorous, healthy plant is of prime importance for success in transplanting. It should have a compact but well-branched root system with plenty of fibrous roots and a top well formed for the purpose for which it is intended.

A crooked or misshaped top is unsightly and is difficult to remedy, but a poorly developed root system is often worse, because it is upon the roots that the plant depends for support and sustenance. If the roots are poor or deficient, the whole plant is handicapped for lack of proper support.

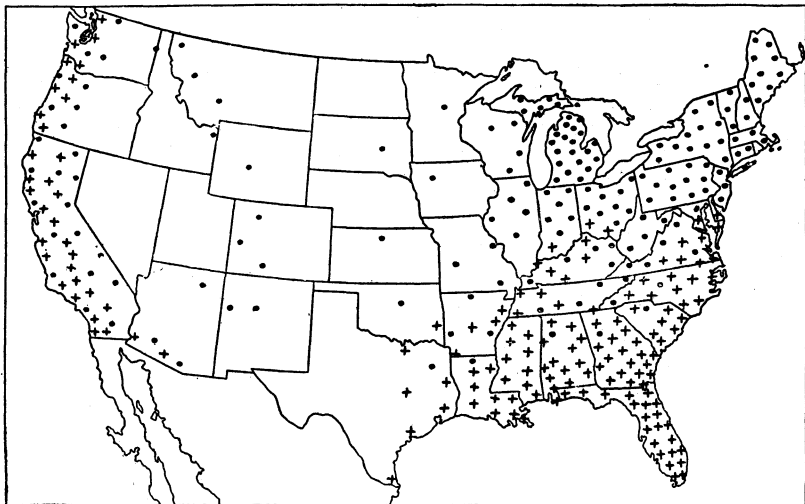


FIGURE 3.—Outline map of the United States, showing where different types of evergreens thrive in greatest number and are most readily cultivated. Dots show where coniferous evergreens are likely to be most successful and the crosses where broadleaf evergreens succeed. The areas where the greater number of kinds of these plants will thrive with the least special care are indicated by the closeness of the marks

The plant should also be free from disease and insect infestation, as it is much easier to keep a plant free from troubles than to eradicate them if they once become established.

RIGHT SEASON FOR TRANSPLANTING

The time for transplanting varies with each type of plant and each region of the country. Deciduous plants are ordinarily moved while dormant, a period from the time seasonal growth ripens in fall until just before root growth starts in the spring. With extra care they may be moved at other times. In most of the eastern United States they may be moved either in the fall or in the spring (fig. 4), whenever the ground is not too wet. On the Pacific slope the fall is more desirable because of the longer time afforded for roots to form before hot, dry weather comes. In the colder parts of the intermediate region only spring transplanting should be attempted, unless it is possible to water the plants thoroughly in the fall, to mulch them to

prevent the ground from freezing as deeply as the roots extend, and to protect the tops by wrapping or boxing so that the winter winds will not dry them out. In the warmer sections of the intermediate region fall transplanting is probably best if an abundance of water can be supplied. Provided there is ample water in the soil, the longer the planting is done before hot weather the better.

A few deciduous plants, such as peaches, rose of Sharon, some magnolias, and the tulip tree, thrive better when planted in the spring, even in regions where fall transplanting is usually most desirable.

Evergreens must be moved with soil about the roots so that interference with the supply of moisture to replace that lost by transpiration from the leaves will be reduced to a minimum. The moving should be done at times when root growth is most likely to take place

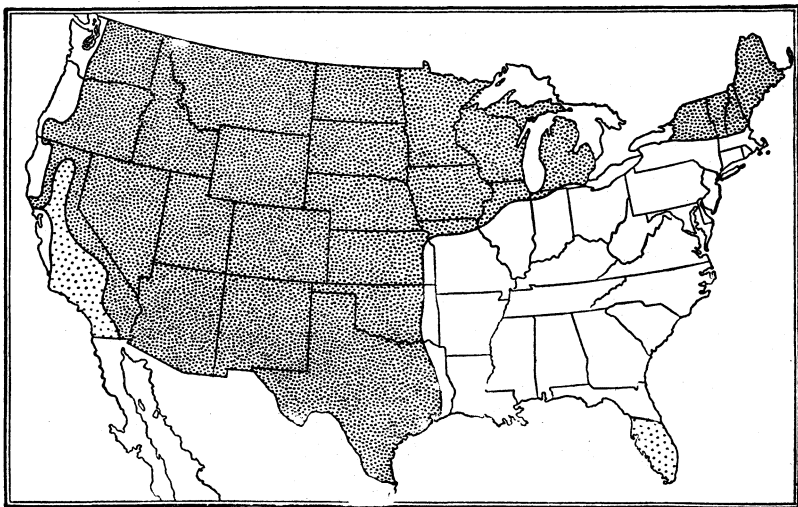


FIGURE 4.—Outline map of the United States, showing seasons for transplanting in the various regions. The white areas indicate where fall is at least as favorable a time as spring for transplanting most plants. In the darkly stippled areas transplanting should be done only in the spring unless special care is exercised. In the lightly stippled areas evergreens may be transplanted whenever moisture conditions are favorable, whereas such deciduous plants as will thrive should be planted as soon as possible after they become dormant.

rapidly, in order that the plants may become reestablished promptly. Small plants from seed beds or cutting frames are often transplanted without earth about the roots, but they require special shading and watering until they become reestablished.

The time for transplanting evergreens in the spring in any locality begins just as the earliest deciduous plants are coming into leaf and continues for a month, or until the growth of the latest deciduous plants is well started; and a favorable time occurs again after the rains begin in the late summer or fall until about a month before it is cold enough to freeze the surface of the ground at night. Where the winters are mild, evergreens may be transplanted any time during that season; in humid climates the transplanting may be done all summer if sufficient attention is given to watering. In places having wet and dry seasons it is best done at the beginning of the wet season.

GOOD DIGGING

Good digging means getting most of the roots with little if any bruising. This can be well done with an ordinary mattock and spade, although where many plants are to be dug it is desirable to have spades with specially reenforced handles that may also be used for prying without danger of breaking. For digging large numbers of trees from nursery rows, specially designed tree diggers for operation by the aid of horses are often economical and satis-

factory. Deciduous plants are usually dug without soil about their roots. If they have been well grown in a nursery they are comparatively easy to dig with most of their roots (fig. 5), because a young plant, or one that has been frequently root pruned, has a compact root system that with care can be dug without serious mutilation. The feeding rootlets and many of the smaller roots, however, will be lost even with careful handling.

Digging plants from woods or wild copses is more arduous, for these plants have comparatively few roots, which usually run long distances and intertwine with the roots of neighboring plants, making it difficult to



FIGURE 5.—Carefully digging a nursery-grown tree

uncover them to the ends. Collectors of wild plants are often satisfied to dig but a short distance from the crown, then hack off the roots, a practice that usually results in the loss of the plants. Because of this difficulty of obtaining an adequate root system for large wild plants, it is best to use only the smaller sizes.

The digging of evergreens must be done even more carefully, so that a good ball of earth is obtained with practically all the roots remaining in unbroken contact with the soil. When such contact is maintained it is possible to prevent injury from transpiration by irrigating until the root system is sufficiently extended into the new

soil to supply the top with moisture. Although an evergreen may be well root pruned in the nursery, it is seldom possible to dig it without severing some roots, but as many as possible should be retained in the ball. In handling, there is great danger that the vital contact of the roots with the soil may be loosened, to prevent which the ball of earth is bound securely with burlap or other suitable wrapping material. (Fig. 6.)

Evergreens growing wild that form a compact mass of fibrous roots can often be collected with success, but those that form long roots running to greater distances are not so successfully moved without the special root pruning already described.

ROOT PROTECTION

Among the principal causes of death among transplanted woody plants are the following: (1) Drying at some time between digging and replanting. This is most frequently due to exposure of the plants, especially the roots, to the air or sunshine (fig. 7), so that they are killed before planting.

(2) Freezing and rapid thawing of roots not in contact with soil; as, for example,

those of plants packed for shipment. (3) Transpiration of more water from the leafless tops than the newly set roots can supply, either because the ground freezes deeper than the roots extend, thus precluding the possibility of the roots obtaining water, or because a dry atmosphere or high winds result in such excessive evaporation from the trunk and branches that the roots are unable to supply the necessary moisture. (4) The starting of top growth more promptly and vigorously than root growth after replanting.

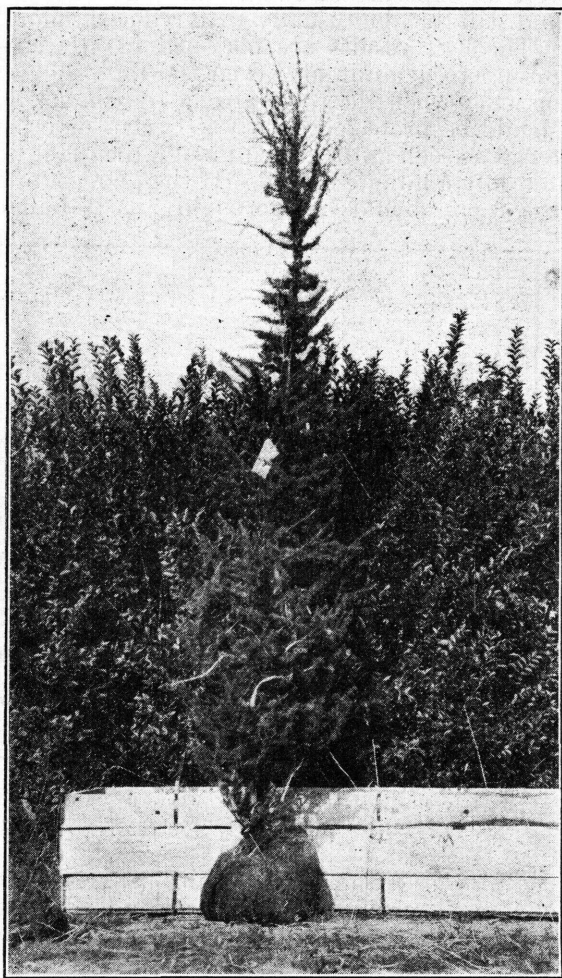


FIGURE 6.—A cone-bearing evergreen with a well-wrapped ball, as received after shipment

The extent of root exposure that a plant will survive varies greatly, some classes withstanding very much more than others. For example, an exposure of the roots of cone-bearing trees for even a few minutes will cause the resinous sap to harden and thus kill them. On the other hand, the roots of elms and maples may at times survive an exposure of two or three hours or more to air and sunshine and still live, but usually with reduced vigor.

The best results are obtained in all cases by reducing root exposure to a minimum; even the tops should not be exposed to sun or wind when the roots are not in contact with the soil. The roots should be protected with wet burlap or other moisture-holding material as soon as dug, even though the plant is to be out of the ground for only a minute or two. If the plant is to be held for later setting, the roots should be thoroughly packed in damp moss, shingle-toe

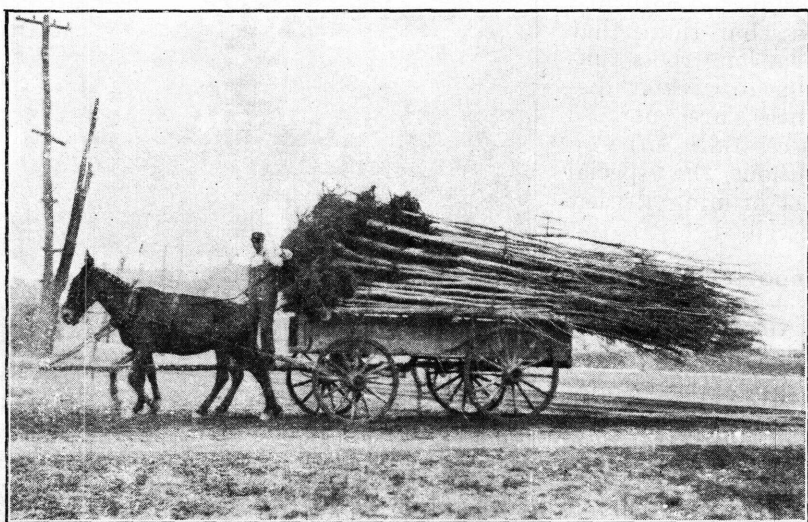


FIGURE 7.—A load of trees with roots so exposed that their chance of giving the best results is greatly reduced. There is always danger of this treatment killing the trees. A covering of wet canvas would have minimized the danger of injury

chaff, or other moisture-holding material. Dipping the roots in soft clay mud, "puddling," as it is called, likewise helps to keep the roots moist. This is not a substitute for careful packing as just suggested, but it helps to make such packing effective.

If for any reason it should be necessary to hold plants for some time after digging, their roots should be covered with soil temporarily, or heeled in, until planting time. This is usually done by digging or plowing a trench large enough to receive the plants, throwing all the dirt out on one side of the trench. (Fig. 8, A.) The roots are then placed in the trench with the base of the stems laid against the earth that was thrown out and the tops almost lying on the ground. (Fig. 8, B.) If the plants are in bundles these must be opened and the roots separated so that all will come in contact with the soil. The roots are then covered with soil, which should be worked in well about them. The soil used for covering

the roots of the plants in the first trench may be so dug as to form a second trench adjoining the plants in the first if more room is needed. More plants may then be placed in the second trench with the same arrangement as in the first, the work continuing until all are heeled in. (Fig. 8, C.) Frequently, trees with large roots may be more easily covered by digging a hole and placing the tree in an upright position as when planted. (Fig. 9.)

If the roots of plants from a nursery appear dry when unpacked, soaking them for two or three hours or more before heeling in is helpful and may save the plants. Burying deciduous plants, tops and all, is often advantageous under such conditions, and puddling may be used in connection with the other restoratives. Likewise, if evergreen plants are not to be set immediately upon receipt, it is well to bury the balls, burlap and all, in a shady place protected from winds, keeping them well moistened until planted.

Sometimes plants in boxes or bales are frozen during transit. Injury from such freezing may often be prevented by placing the unpacked bale or box in a cellar or other place with the temperature only slightly above freezing, to induce gradual thawing. When completely thawed the plants should be heeled in until planting time.

Small evergreens, which are frequently shipped without balls, should be unpacked and heeled in immediately, preferably in shade, or be provided with some artificial shade such as brush, burlap, or the like.

PREPARATION OF THE HOLE

A hole should be dug sufficiently large to take all the roots without doubling them back and deep enough so that with 2 to 3 inches of rich soil in the bottom the plant will stand at the same depth as in the nursery. Holes for very small plants are often made at the time of setting with dibble, spade, or mattock. Often in nursery and orchard planting, as well as in some types of forest planting, furrows are plowed instead of digging individual holes. If it seems desirable to dig the holes, and if subsoil has to be excavated in order to make them sufficiently deep, it usually should be done in advance of the receipt of the plants. If the hole is so located that it would be dangerous to permit it to remain open, it may be refilled with proper soil for planting. So prepared, a hole is quickly and easily reopened when the plants arrive.

The hole for an evergreen should be prepared sufficiently wide to permit the ball to be placed readily and also to provide space for good, well-enriched soil about it. Also the hole should be of a depth to permit the placing of 2 to 3 inches of good soil under the ball and still have the plant at the depth it was before transplanting.

When it is anticipated that it will be advisable to set a plant when the ground is frozen, the soil where it is to be located may be kept from freezing by a heavy mulch of manure. This also helps to keep the soil from becoming overwet, so that the excavated soil can be used for setting the plant. The hole may be dug before freezing weather comes and then be filled with manure to keep the bottom from freezing, as it is undesirable to plant on frozen soil. Special provision must sometimes be made to keep soil for planting sufficiently dry and free from frost.

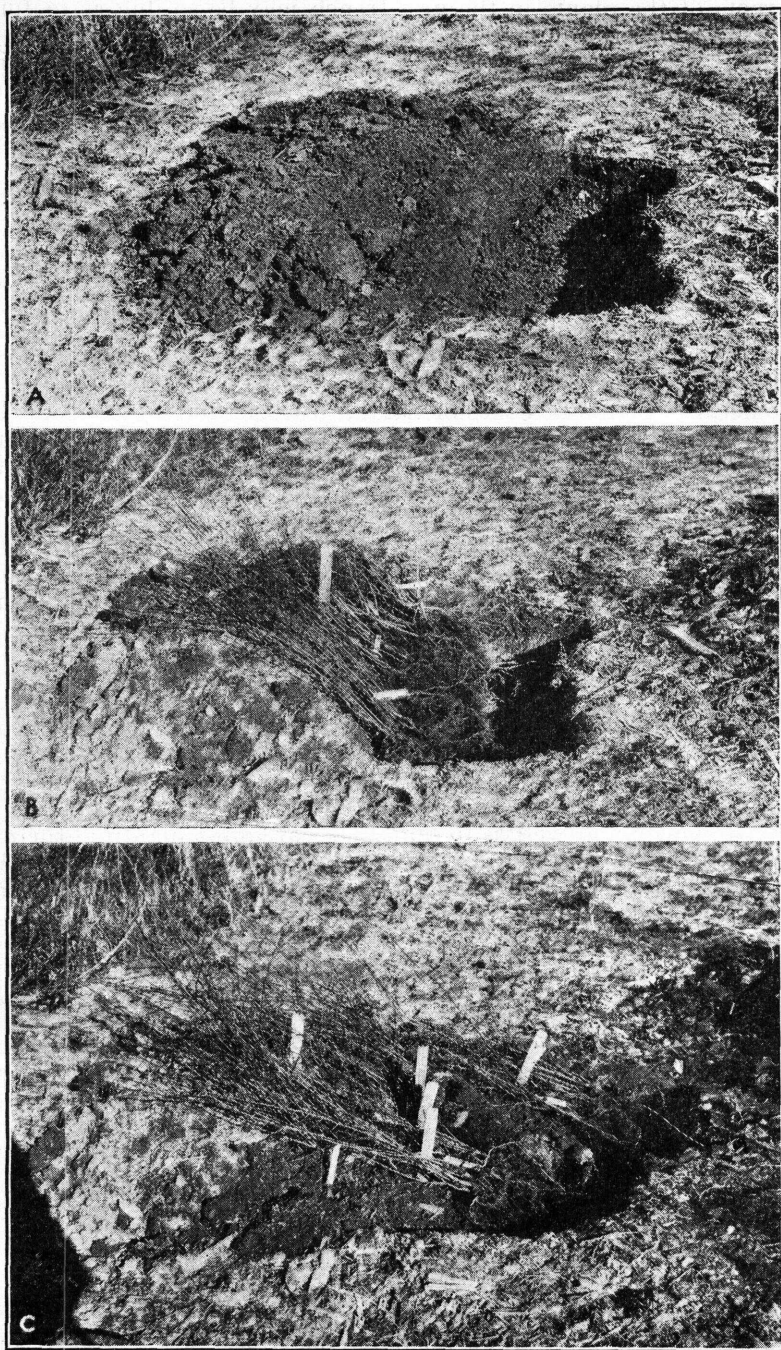


FIGURE 8.—Heeling in: A, A trench prepared for the reception of shrubs or small trees; B, the first row of plants in place; C, the first row of plants covered, the second row in and partially covered, and the third row partially in place

SUITABLE SOIL

The topsoil removed in digging the hole should be saved for putting back about the roots; the subsoil that is not suitable to use should be taken away and replaced by good soil. The earth that is to come in direct contact with the roots of deciduous plants or the balls of evergreens must be free from lumps or clods and stones. Well-rotted manure, other compost, ground bone, tankage, fish scrap, or cottonseed meal may be sparingly mixed with the soil to be placed about the roots of the newly set plant, but should not come in direct contact with them. Most of the feeding, however, should be done after the plant has become established.

For successful transplanting the soil must be in good condition, neither too dry nor too wet, but of such texture that it can be brought into close contact with the roots without danger of its packing so hard about them as to become bricklike on drying. Light soils generally do not so behave, and heavy soils will not if they are sufficiently dry to fall apart again after being squeezed tightly in the hand. If heavy soil is too wet for good results, the plants should be heeled in until it is in proper condition, even though this delay carries the planting beyond the best season for it.

The probability of unfavorable planting conditions can often be foreseen and sometimes be offset by storing good soil under a shed where it will not become too wet, or by building a shed roof over the stored soil near the site of the proposed planting operations. A supply of dry soil for use in filling in about the roots sometimes permits planting to be done when otherwise it would be impracticable.

Most plants thrive in an almost neutral soil, but some require an alkaline and others an acid soil. Plants are known to have special

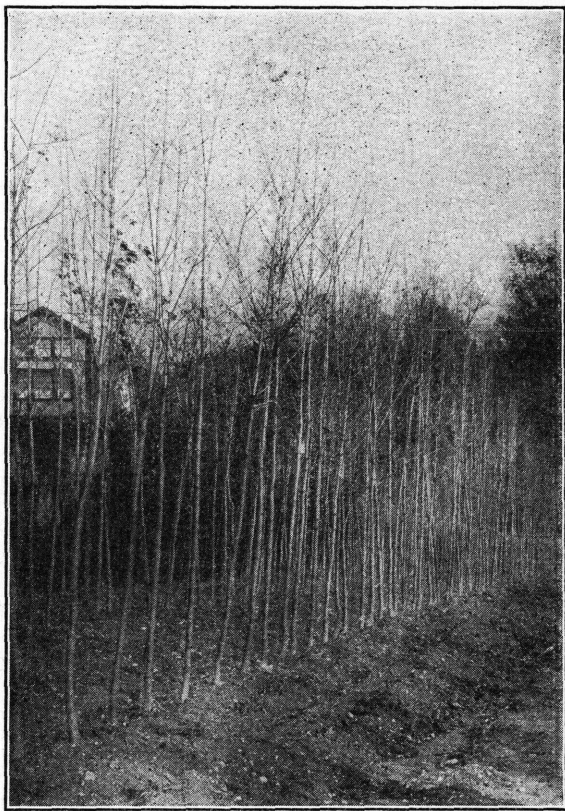


FIGURE 9.—Upright heeling in, as practiced with large trees preparatory to final planting

requirements, and these should be provided for in the preparation of the soil. Partially decomposed stable manure with such supplements as lime and wood ashes produce sweet or alkaline soils that are especially favorable for leguminous plants and in a lesser degree for those of the rose family, whereas rhododendrons and other ericaceous plants want the acid conditions produced by leaf mold prepared from oak leaves, pine needles, and such supplementary material as aluminum sulphate. Many of the cone-bearing trees also seem to like more or less acid conditions.

PROPER SETTING

The plant should be set at the same depth it grew in the nursery. (Fig. 10, A.) This is not difficult with plants of moderate size having no earth on the roots, as they may be held readily in the proper position while planting proceeds. Heavy plants, however, especially those with a ball, are not so easily handled. Usually it is best to start with the plant or ball 2 or 3 inches deeper than required, gradually working soil under it first on one side, then on the other, tipping the plant from side to side to facilitate the operation until it is at the proper depth, making certain that no cavity is left under the middle of the ball.

Evergreens are often planted without removing the wrapping of burlap from the ball if the soil is inclined to loosen from the roots and there is no straw or other packing inside. Burlap is usually so loosely woven that small roots penetrate it easily but their growth through it may be facilitated by cutting gashes at several points on the sides and bottom. When planting is nearly completed the burlap that might otherwise protrude from the ground can be cut off just under the surface. If a layer of straw, canvas, or any thick, heavy wrapping material has been used it must be removed before planting, because it would act as a barrier to the passage of moisture and the growth of the roots.

Rhododendrons and other shallow-rooted plants are set practically on the surface of the ground, because their growth is mostly in the layer of leaf mold that covers the forest floor where they grow naturally. Frequently they are placed on the surface of the soil, and a good layer of leaf mold is put between them, and a mulch of leaves, as the thin layer of leaves and leaf mold that comes with the plant may be called, is put over the ball. When they come with as deep a ball as other evergreens, they must be provided with a correspondingly deep hole.

CORRECT PLANTING

Very small plants are often set by making a slit in the soil with a dibble, spade, or mattock, working it backward and forward sufficiently to make a slight opening, then placing the plant at the proper depth with the roots spread fan shape, after which the implement is removed and the earth is firmed about the roots, usually by pressure of the foot or some times by another thrust of the implement followed by a push of the handle in such a manner as to press the soil firmly about them. After a larger plant is properly placed, fine earth should be well worked in among the roots (fig. 10, B), which should be placed as nearly in the position in which they grew as possible,

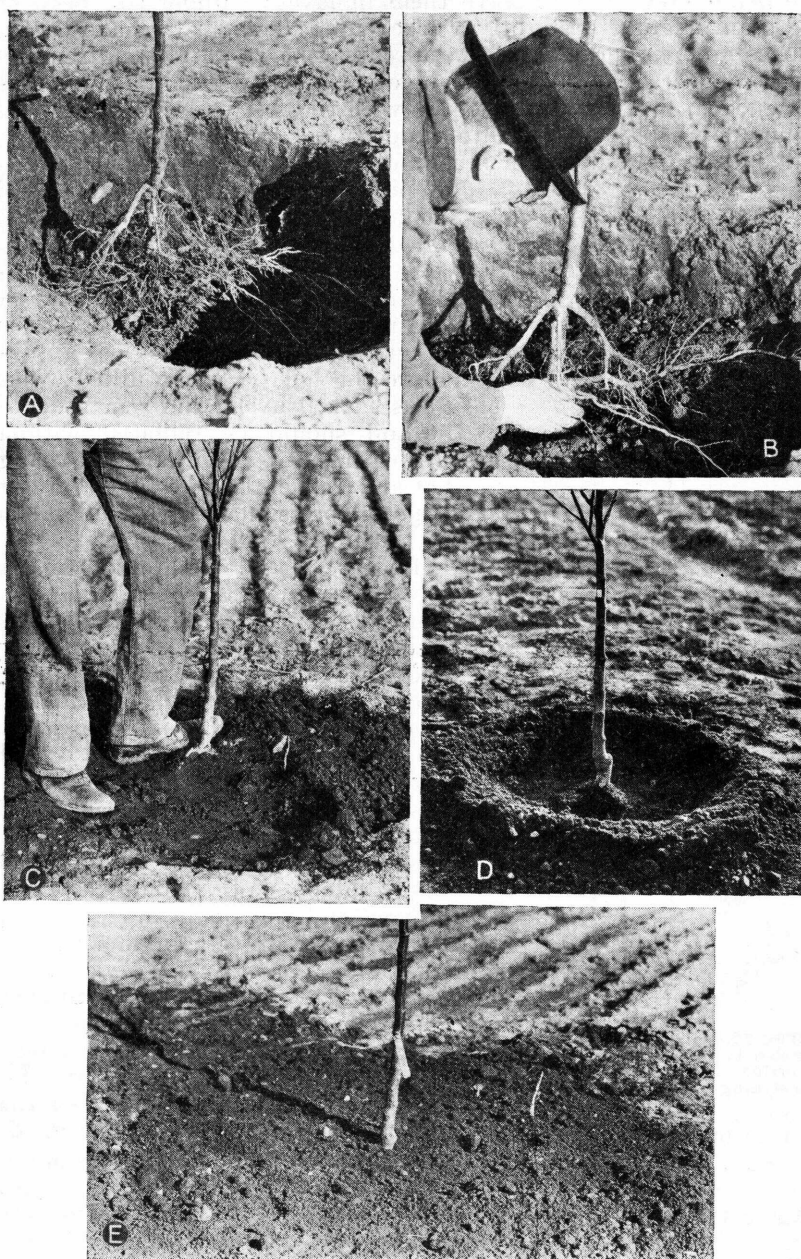


FIGURE 10.—Steps in the transplanting of a young deciduous tree: A, A hole of ample proportions for the spread of the roots, with the tree placed in it at the same depth it grew in the nursery; B, working fine soil about the roots when partially covered; C, firming the soil about the roots; D, roots covered, leaving a depression to receive water; E, the filling of the hole completed, fine soil having been used to make the surface level, with no further compacting

care being taken not to leave them in layers without soil between. The plant should be slightly worked up and down to make certain there is no opening left under the roots, especial care being required where they branch. When the hole is partially filled the soil must be well firmed either by tramping with the feet or by tamping with a blunt stick to bring it into close contact with the roots. (Fig. 10, C.) The hole should then be filled with loose soil without further tamping. (Fig. 10, E.) The soil should be similarly firmed when a balled tree is planted.

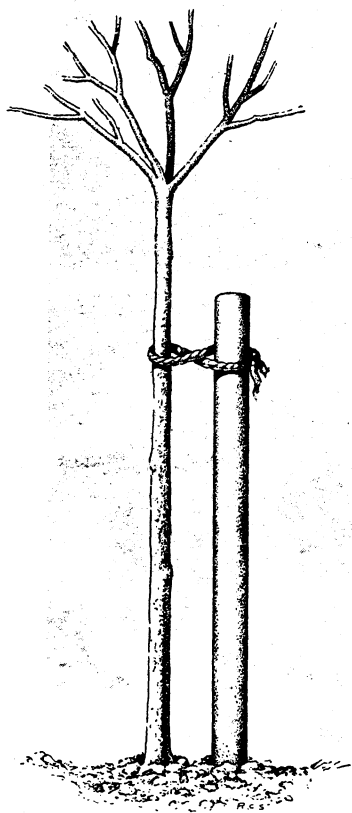


FIGURE 11.—A newly planted tree which is well attached to a supporting stake by a figure 8 fastening of some soft material

If the soil is very dry, or if the planting is being done late and the weather is hot, or if the plant is an evergreen, water should be applied before the hole is finally filled; when it has soaked away, the remainder of the soil should be replaced without further firming. For later waterings that are frequently necessary a saucer-shaped depression may be made about the tree. (Fig. 10, D.)

If there is a possibility of the winds swaying and loosening the plant in the soil, it should be staked. A simple method is to drive a heavy stake into the ground a few inches away from the trunk, to which a piece of soft, firm binding material like leather, old rubber hose, or soft rope is attached near the top and passed around the tree and back to the stake in such a manner as to form a figure 8. (Fig. 11.) This serves the double purpose of a buffer between the tree and the stake and a support to prevent swaying. Another support is made by driving three stakes about the tree at nearly equal distances, united by cleats from which loops of binding material are passed around the trunk of the tree, each being fastened to a cleat in such a manner that

the tree will have little space to be swayed by the wind. (Fig. 12.) Tree guards or boxes, such as are frequently used on city streets, may also be used.²

After transplanting, if top growth starts before new roots have formed, the demands of the new foliage for moisture in addition to that required by twigs and branches may so dry out the whole plant that it will die before a sufficient quantity can be supplied by new root action. To prevent this condition early planting is desirable, and even fall planting in those regions where the winters

² Types of tree boxes are shown in the following publication: MULFORD, F. L. PLANTING AND CARE OF STREET TREES. U. S. Dept. Agr. Farmers' Bul. 1209, 32 pp., illus. 1921.

are not too cold. Plants set in the fall a month before freezing weather in a favorable climate will sometimes form new feeding roots 4 inches in length before winter, thus insuring prompt root action with renewal of spring growth. In severe climates, however, the ground sometimes freezes below the newly planted roots so that they are unable to absorb water, yet the tops, even though leafless, continue to lose moisture, and the death of the plant results. This occurrence is particularly likely if the freezing weather is accompanied by strong drying winds, as is usual on the northern Great Plains. In such cold climates mulching with coarse manure or straw about the trees will aid by preventing frost from penetrating the ground too deeply and in dry climates by holding moisture.

The roots usually begin growth before the top starts. It sometimes happens, however, that hot weather follows immediately after planting, and the top starts into active growth while the ground is still so cold that there is little root action. Watering is best under these conditions, but where this is impracticable or seems not to be fully effective the best that can be done is to reduce greatly the leaf surface by severe pruning. Such radical pruning, however, is only warranted under extreme conditions.

Care as to mulching and especially as to watering must be given evergreens after planting. A warm soil with a moderately cool moist atmosphere, conditions that encourage root growth while retarding top growth and reducing transpiration, are the most favorable factors for success.

Small trees for the establishment of forests in open areas in humid regions probably receive the least attention to the niceties of handling as discussed in this bulletin. To make forest planting economically practical, the trees must be planted at small cost, therefore small sizes are used, and they must be planted rapidly to keep down the labor expense. The other extreme is the handling of ornamental plants where large sizes are used and many kinds are planted that are difficult to move. Many of the more attractive sorts require special skill in growing as well as special care in transplanting. The adding of beauty in various forms to human surroundings fully warrants the required care and expense.

Orchard trees and small-fruit plants require more work than forest trees because larger sizes with a different type of root system are used. Extra attention is warranted because the number of trees handled is few compared with forest planting, and rapid growth from the beginning is an important aid toward producing profit-making plants. Shelter-belt planting often requires much more care than orchard planting because it is usually done in regions

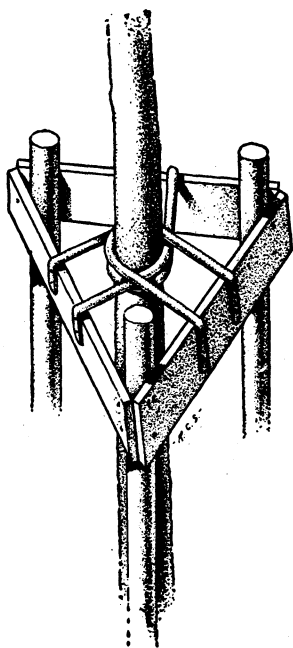


FIGURE 12.—A tree guard which provides more protection and better support than that shown in Figure 11, but the same soft binding material must be used

where it is difficult to establish tree growth, therefore more careful attention to details is required, watering often being necessary to insure success.

The care required in transplanting in the nursery varies with the kind and age of plants and the climate and season.

PRUNING

Top pruning should be somewhat proportioned to the root loss in digging, in order to reduce the demand for moisture, thus enabling the roots to supply that needed when the plant starts to grow. Usually this means that one-half of the top of large deciduous plants

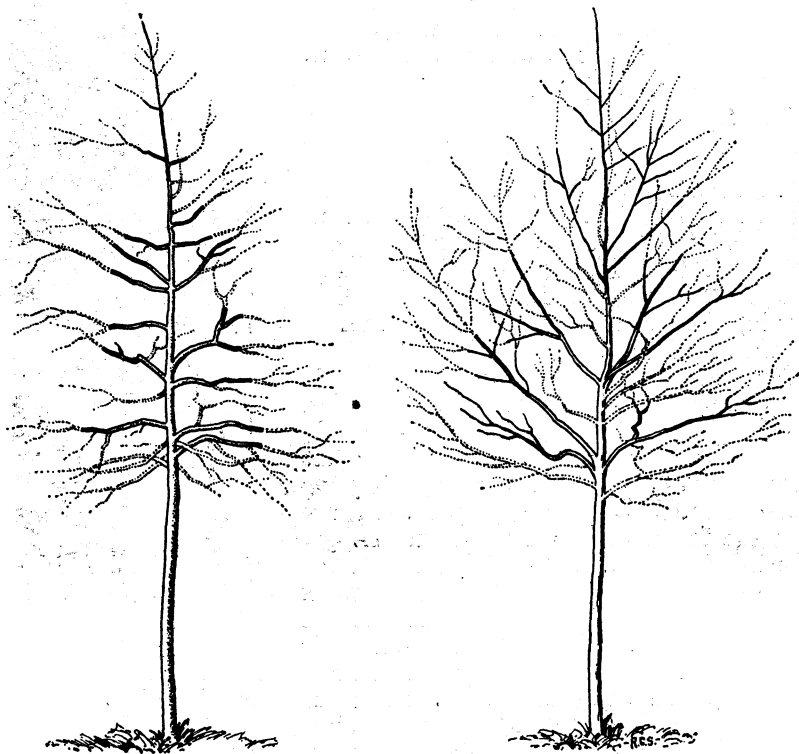


FIGURE 13.—Trees well pruned for transplanting

should be cut away when the plant has been well dug and handled, and three-fourths or more if it has been poorly handled. As far as possible this should be done by removing whole limbs or branches and cutting back the ends of the remaining branches. The general shape or character of the plant should be kept as nearly as possible. (Fig. 13.) Cutting back the large branches to mere stubs should be avoided.

Deciduous plants up to 3 or 4 feet high, or larger ones that form roots readily, if they are carefully moved, may be successfully replanted without being pruned. Plants moved with a ball of earth in the same manner as evergreens may be left unpruned, even though they are in full leaf. If roots are cut off short or are badly mutilated

in digging, as so often happens when wild plants are dug, the tops must be much more severely pruned than when a good root system is obtained. It is often best to leave only a short trunk or a few stubs of branches from which a new top may be grown.

If evergreens are provided with a good ball and are carefully handled it will be unnecessary to prune when they are transplanted. Some of the broadleaf evergreens, such as the hollies and evergreen magnolias, although more successfully transplanted with a ball, may be handled as deciduous plants if they are severely pruned and all the remaining leaves are picked off.

WATERING

While the plant is becoming reestablished, watering may be necessary at planting time as well as later to maintain an ample moisture supply. Evergreen plants require more watering than do deciduous ones. In dry climates they require daily watering; in moist climates in an ordinary season less frequent watering is needed. Moreover, the tops should be sprayed several times a day to reduce transpiration from the foliage as much as possible. In regions of limited rainfall and dry winds more attention is required

than in more humid sections. A burlap screen on the windward side is found to be a great help in reducing transpiration. (Fig. 14.)

To facilitate watering, it is best to build a basin about the plant by ridging up soil at a little distance from it so that the water when applied will soak into the ground without running away. Watering is best done by pouring on a little and permitting it to soak away, repeating several times until the ground is thoroughly wet to the depth of the roots. Wetting the surface only is useless. Where there is a ball in which roots are located it is more important that water penetrate it than that it penetrate the surrounding soil. This operation must be repeated often, until the plant becomes reestablished.

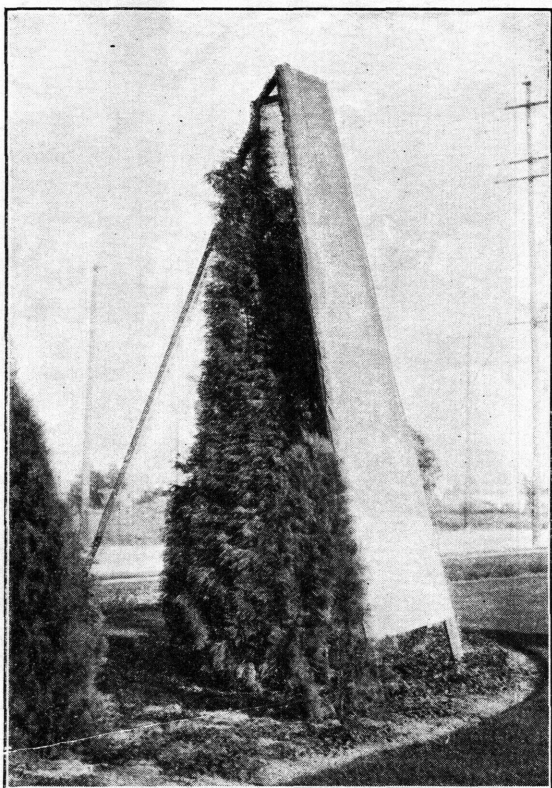


FIGURE 14.—A burlap screen to reduce transpiration from the top of a newly planted evergreen by protecting it from prevailing dry winds



FIGURE 15.—Uncovering the roots of a large deciduous tree preparatory to removing it. The work is done carefully, so as to destroy as few roots as possible. In sunny weather the roots should be wrapped in wet burlap as they are exposed

A surface mulch of straw, leaves, or similar material helps to hold moisture and often aids the plants to reestablish themselves. Surface-rooting plants, such as rhododendrons and other ericaceous plants, require a mulch as a means of both holding moisture and providing a medium in which the new roots may develop.

HANDLING LARGE TREES

Sometimes it is desirable to move trees larger than it is practicable to handle without special equipment. Such trees are moved to get quick results on new grounds; to fill gaps in formal plantings with trees of a size to correspond with the others in the design; or to save for future crops valuable orchard trees that would otherwise be

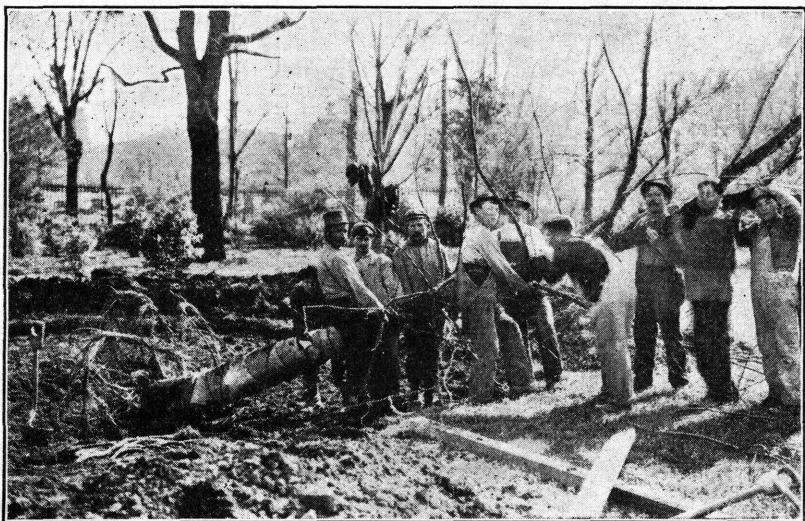


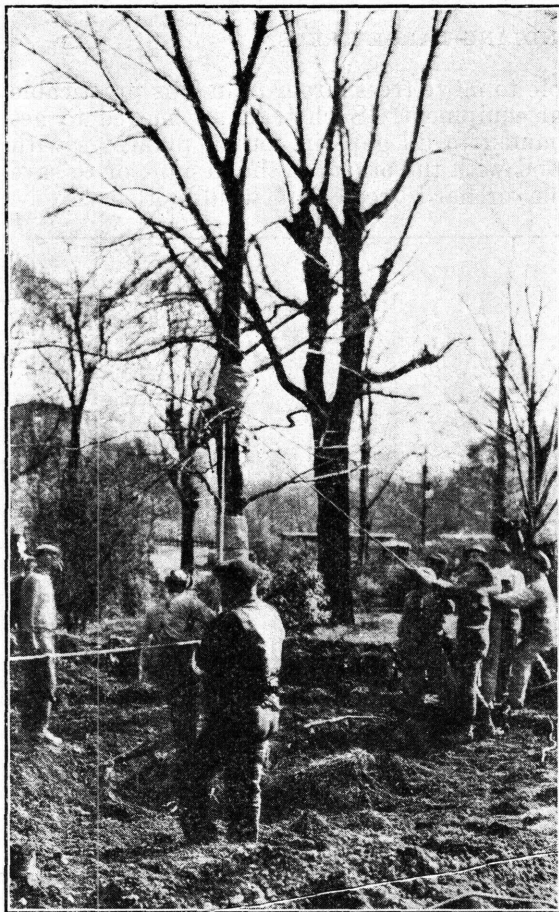
FIGURE 16.—An elm ready to be set in a new location. The rope attached about a good wrapping of burlap near the middle of the trunk is ready for raising the tree into an upright position and holding it there until the roots are covered

destroyed. It is expensive work, the cost increasing very rapidly with the increase in the size of the plant to be moved.

The easiest and most practical way of doing this work is always sought. Some firms have developed special equipment which enables them to meet the mechanical difficulties of handling large plants; trees even 40 feet or more in height with balls of earth weighing tons are transplanted by such means. This equipment includes devices for holding the ball of earth intact and contrivances for lifting and carrying the tree to its new location. Some of these devices are patented. A derrick truck used successfully for moving hundreds of flowering cherry trees is shown in action in the illustration on the title-page.

The trees are dug with little or no soil adhering to the roots, or they are moved with a ball of earth, on the same principle as governs the moving of small evergreen trees, already described. The former practice is suitable for moving many deciduous trees when grown on

sandy or light soils; the latter method is essential in handling evergreens, deciduous trees grown on heavy or tenacious soils, and also if they are moved when they are in leaf. Trees in active growth, however, should be moved only in an emergency, as the risk is too great to justify it otherwise.



HANDLING ORNAMENTAL TREES WITHOUT A BALL

Large trees are successfully dug only from light or friable soils, because in heavy soils it is difficult to locate and remove the smaller roots without injuring or breaking them. The trees are dug with spading forks, beginning at the outer ends of the roots sometimes as much as 40 feet from the trunk. The digging is begun at the outer end, as the roots can be safely protected from drying with less wrapping and the anchorage of the tree is not disturbed until nearer the time for moving. As the roots are located they are carefully uncovered (fig. 15) and wrapped immediately in wet burlap to keep them from

FIGURE 17.—Securing the tree shown in Figure 16 in an upright position ready for covering the roots

drying unless it is very cloudy, foggy, or rainy, when wrapping may be somewhat delayed. In windy or bright sunny weather the burlap requires frequent wetting to insure keeping the roots damp. If the roots are to remain wrapped for several days, moss may be used inside the burlap, as it does not dry out as rapidly as burlap used alone. In the eastern United States and in the Puget Sound region in inclement weather, when the air is so full of moisture that there is little danger of the roots drying out, plants may be safely moved without covering the roots; conditions must be watched carefully, however, that drying winds or other unfavorable conditions do not intervene and dry the roots unexpectedly.



FIGURE 18.—Ramming the soil under the crown of a tree to make sure that no air pocket is left, while the roots are carefully spread in their natural position preparatory to being covered

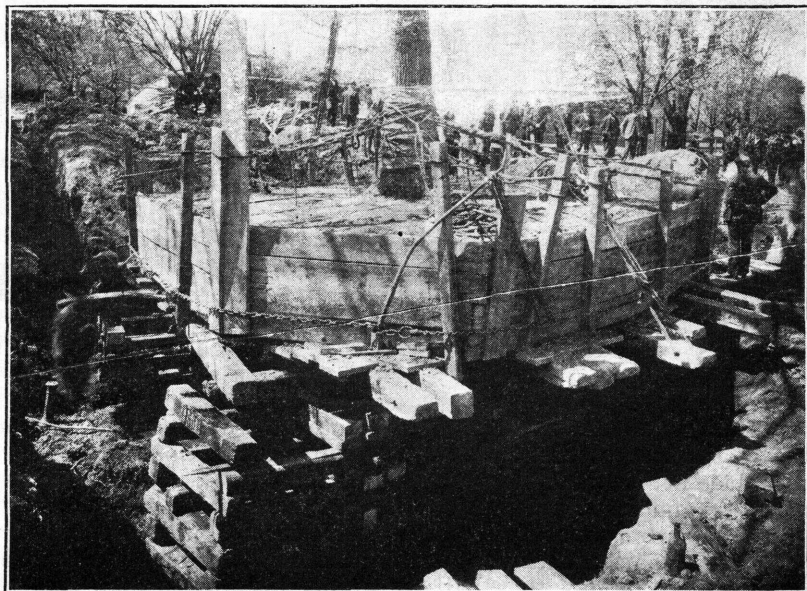


FIGURE 19.—A supporting frame for the ball of a large oak tree

Thus prepared, the tree is moved to the new location either by specially devised derricks, by sleds, by planks and rollers, or in other improvised ways. On reaching the new location the tree is placed on a previously prepared bed (fig. 16) and guyed after it is in an erect position (fig. 17), while the roots are spread out in their natural positions (fig. 18) and carefully covered with good soil. Special attention must be given that they are in the ground at approximately the same depth that they were previous to the transplanting. It is most important that the space under all the roots be filled with well-compacted soil.

The pruning of large trees must be somewhat proportionate to the amount of root loss that has occurred.

HANDLING ORNAMENTAL TREES WITH A BALL

Soil must be held closely about the roots of evergreens or deciduous trees when moved with a ball, so that the contact of the roots and soil will not be loosened. This is more easily accomplished if the tree is standing in a stiff, heavy soil rather than a soil of lighter type, and with plants that have an abundance of fibrous roots rather than with those having only a few large ones. The ball is usually held together by building around it a support of planks



FIGURE 20.—A ball of earth held firmly by staves kept in place by chains tightened with turnbuckles. The ball and the large root protruding at the left are well protected by burlap

(fig. 19), the area inclosed being square, hexagonal, or some other form that better adapts itself to the size of the ball; or the support may consist of heavy staves fastened around the ball by chains, ropes, or wire, drawn taut by turnbuckles. (Fig. 20.) If the soil is frozen to a sufficient depth it is often possible to move trees without a plank support. (Fig. 21.) Some plants with many small roots growing in a clay soil may be secured with a ball by simply digging around the tree and pulling it. The size of the ball should be the least that is com-

patible with safety to the tree. Soil is so heavy that the weight of a ball which must accompany even a comparatively small tree creates a problem in moving. The character of the soil, the root habit of the plant, and the amount of preparatory treatment are all factors in determining the size of the ball that it is necessary to take. An elm is one of the least difficult trees to move. A ball 6 feet across is sufficient for an elm 25 to 40 feet high having a trunk 12 or 14 inches in diameter. A plant of boxwood growing in a clay soil which has had no preliminary preparation should have a ball as great in diameter as the spread of the branches; a hemlock 10 feet high and previously trenched should have a 5-foot ball.

When the dimensions of the ball have been decided upon, a trench should be dug to a depth of at least 1 foot greater than that to

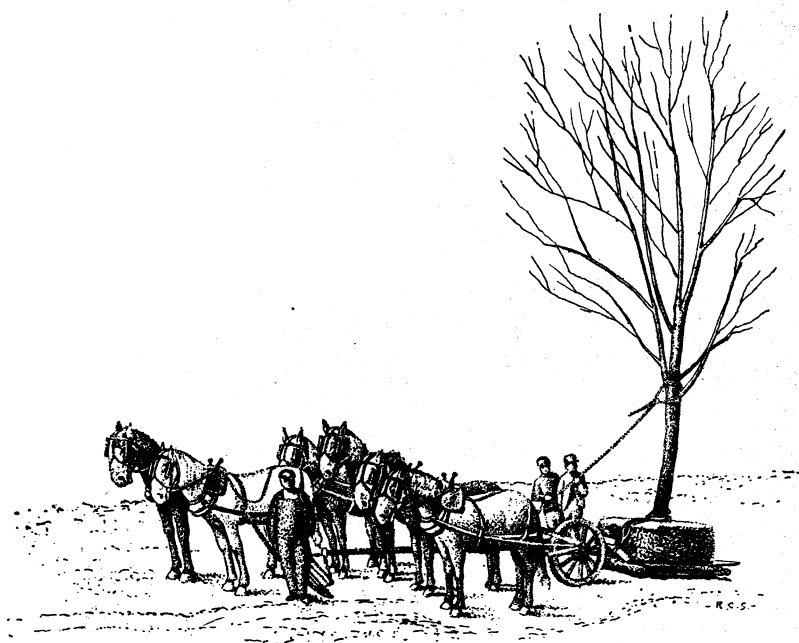


FIGURE 21.—A tree being moved with a ball of frozen earth without a plank support

which the main roots penetrate. Canvas or burlap should then be put on the ball; if the stave method is used, short planks of a length equal to the depth of the ball should be set up around the burlapped ball and held in position with chains, rope, or wire placed near the top and bottom, as shown in Figure 20. The chains should be tightened evenly and as securely as possible without cracking the ball.

The trench should then be dug enough deeper to permit undermining the tree just below the main root system. Planks are worked under the tree to make a solid platform on which the ball with the tree will then rest.

The plant prepared as heretofore described may be raised sufficiently by the use of jacks (fig. 22) so that timbers and rollers may be placed under it so that it may be loaded on a truck. (Fig. 23.)

Block and tackle are used for drawing the plant out of the hole onto the wagon or truck. In moving a very large tree it is necessary to dig an inclined runway from the bottom of the hole to the ground level. The top of the tree should be guyed to keep it upright.

Holes for large trees should be dug with no less care than those for small ones. At least 6 inches of rich soil should be placed in the bottom of the hole. The platform on which the tree was moved should be taken out after the tree has been placed in position, and its space should be filled by tamping in rich soil, working from the center outward. The hole must be of sufficient depth for the surface

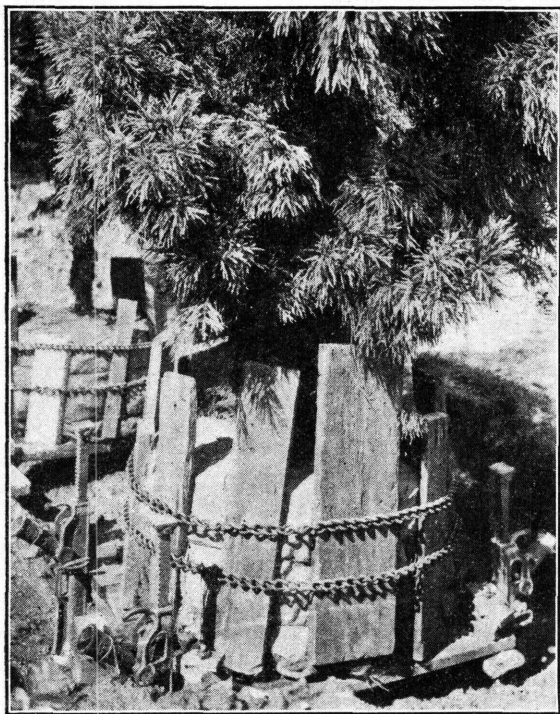


FIGURE 22.—Jacks placed for raising a plant platform high enough to place plank and rollers under it for rolling it out of the hole

of the ball to correspond to the proposed finished grade. This means that the hole must be deep and broad enough to accommodate the ball and the staging underneath, with sufficient room to remove the staging. (Fig. 24.)

In regions where the ground freezes about the roots of deciduous trees to a depth of 1 foot or more, the frozen earth often provides the ball. (Figs. 21 and 26.) This saves much expense in the preparation of boxes or cribbing as already described. A trench may be dug before winter comes and be filled immediately with manure to within a foot of the top. When the

ground is frozen the manure is removed and the ball is undermined. One end of tackle is attached high enough on the tree to give a good leverage, the other end being attached to a post (fig. 25), a bar, or a deadman at some distance. It is imperative that the attachment to the tree should be made in such a way that there is no chance of its bruising or tearing the bark. This is probably best accomplished by making a heavy wrapping of burlap and then so attaching a rope loop as to avoid slipping. The tree is pulled partly over (fig. 25), breaking the ball loose from the ground beneath. While in this position the plank and rollers may be placed under the ball. It can then be let back into position for drawing out; or it may be drawn over in the reverse position and attached to a specially prepared wagon with a high bolster and long reach. (Fig. 26.) If the weather

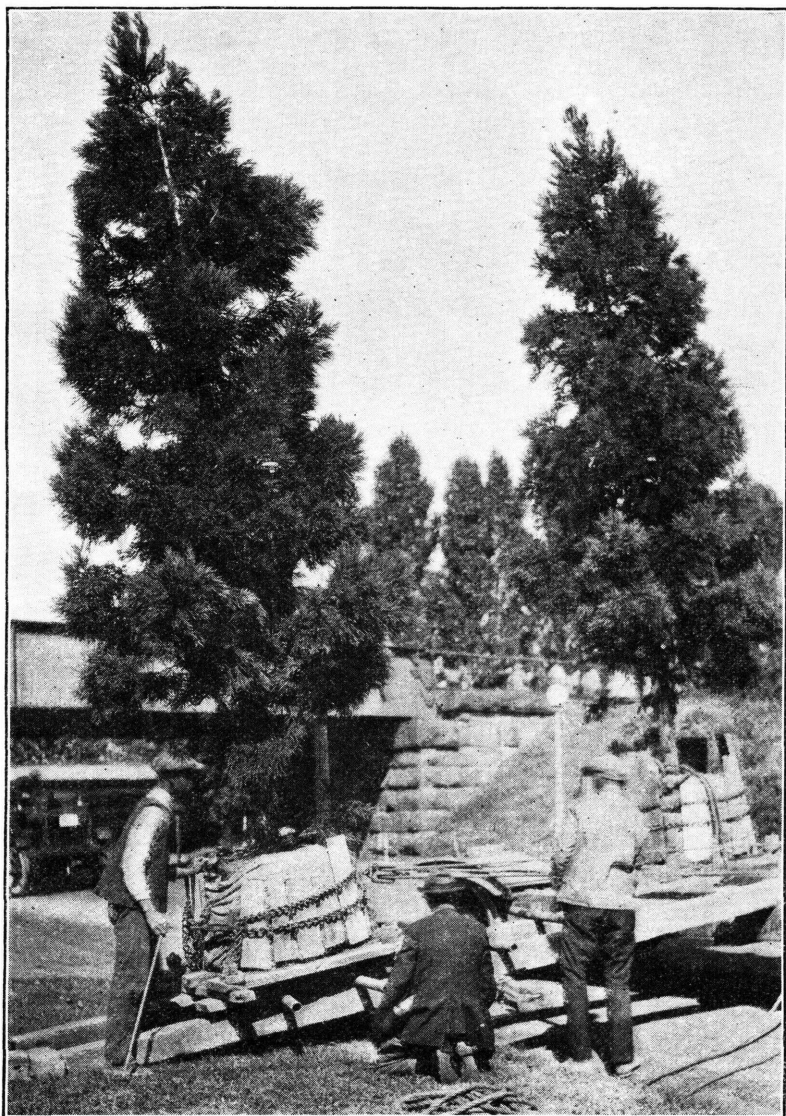


FIGURE 23.—A balled tree being drawn to its place on a truck with block and tackle, the tree support traveling on rollers, with heavy timbers for the runway



FIGURE 24.—A deep hole needed to accommodate the roots of a large tree and allow room for tamping earth under it as the runway and staging are removed

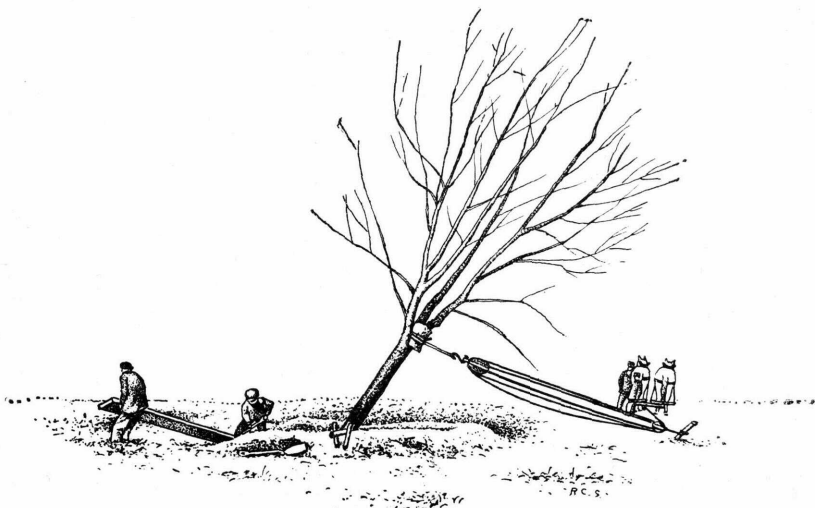


FIGURE 25.—Pulling over a tree with a frozen ball. Note how the tackle is attached to a rope loop over a heavy wrapping of burlap or other protecting material. The loop is drawn up tight before the tackle is hooked in, so that there will be no slipping of the rope to loosen the bark

is sufficiently cold to freeze a ball 1 foot thick and keep it frozen, it may be handled without the staves or other supports already described; but it is best to put them on if it is not frozen to the depth of at least 10 inches.

The digging of holes for planting trees in winter can be facilitated if the spot is covered in the fall with manure to such a depth that frost does not penetrate. The hole can then be dug easily just before placing the tree. The freezing of the bottom of the hole should be prevented by mulching if the tree is not planted as soon as the hole is dug. Likewise, the topsoil removed should be kept free from frost, so that it can be used for packing about the ball of the transplanted tree.

Compacting the soil about the roots or ball is as necessary to success as it is with smaller trees. The loosening of the plant in the soil by wind must be prevented. This may be done by the use of three strong guys placed equally distant around the tree (fig. 27) until it has become thoroughly reestablished.

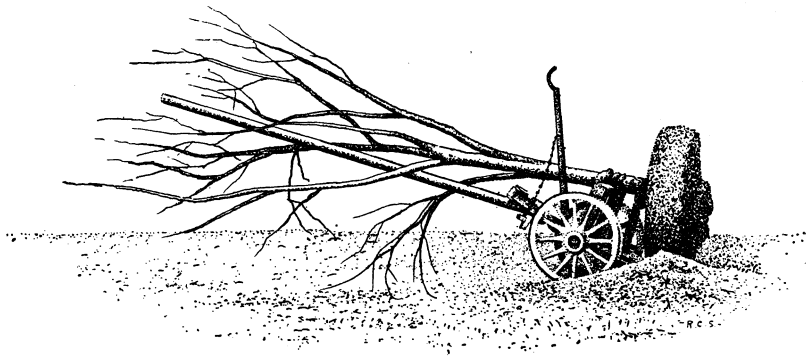


FIGURE 26.—A tree with a frozen ball on a specially prepared wagon frame having a high bolster and a long reach. The trunk must be well protected where it rests on the bolster, so that the bark will not be injured

Closer attention must be paid to watering large trees after they have been transplanted than is paid to the watering of small ones, because of the large proportion of roots that are necessarily lost; hence the remaining roots need to be made as efficient as possible. Draintiles are often placed vertically in the soil about newly set trees, in order that water may be supplied directly to the root-feeding area. This method is preferable to surface watering, as it encourages root growth in the lower rather than in the upper portions of the soil and lessens the possibility of soil baking.

Holly and many other broadleaf evergreen trees may be transplanted like deciduous trees by removing all the leaves; if they are handled with a ball, like coniferous evergreens, the leaves may be left on the plant.

TRANSPLANTING LARGE ORCHARD TREES

Large ornamental plants are transplanted to obtain the effect of masses of foliage in as short a time as possible. For this reason it is

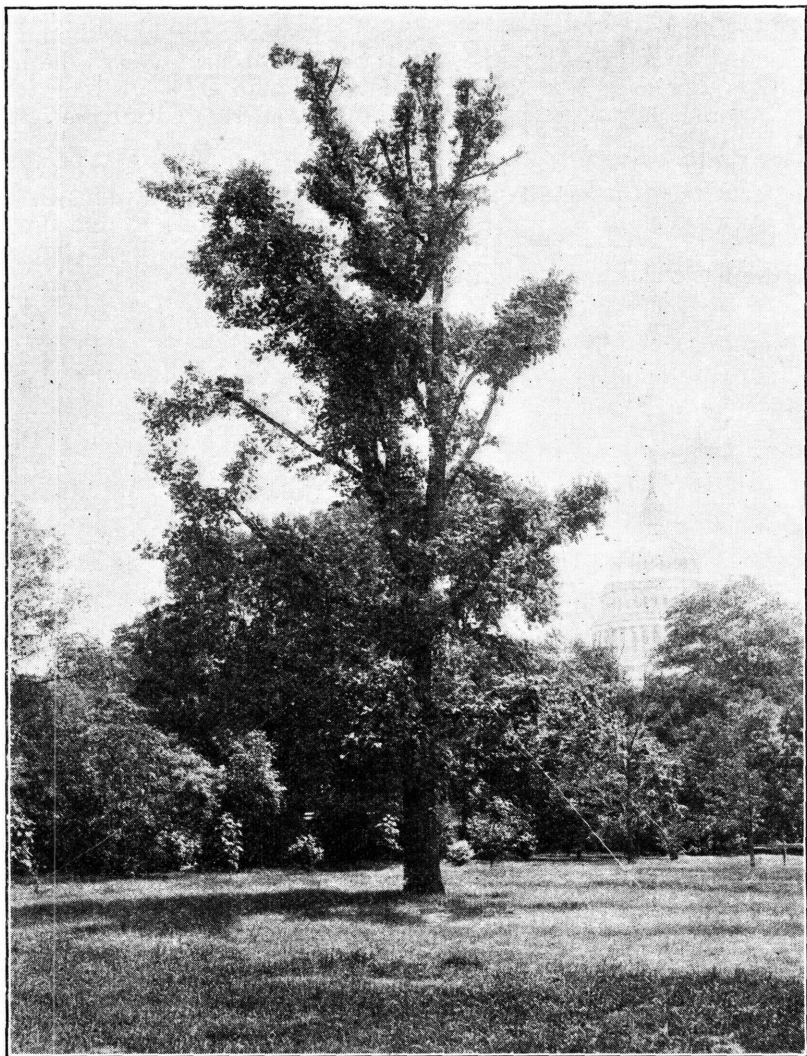


FIGURE 27.—Strong guys supporting a large tree until it becomes thoroughly established, to prevent the wind from loosening it in the soil

essential that a generous portion of the root system be obtained, and pruning of the top is limited to just enough to balance any root loss. In moving orchard trees, however, whether fruits or nuts, the problem is somewhat modified, for it is not the mass of the top that is desired but fruitfulness of the tree upon reestablishment. Trees of a recently transplanted pecan orchard (fig. 28) regarded from the landscape viewpoint would be worthless because of the severe pruning to which they have been subjected.

Large-sized deciduous fruit trees may be economically lifted and reset at short distances in the manner shown in the title-page illustration. To do this it is necessary to dig a trench about the tree; then it may be pulled by the derrick. The bruising of the bark of the trunk must be prevented by placing a heavy wrapping of burlap where the rope loop is attached.

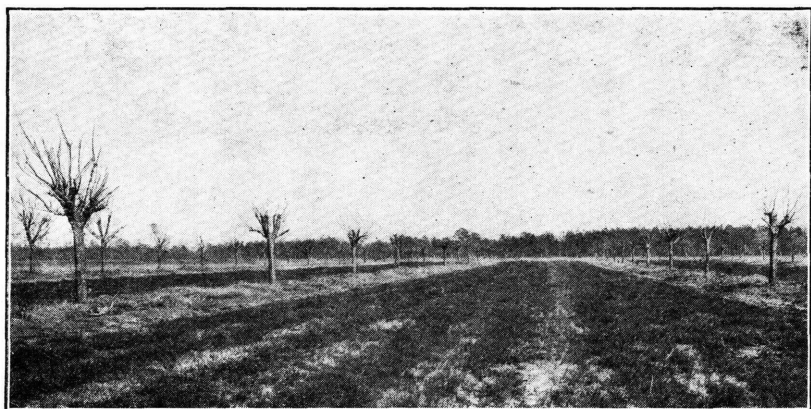


FIGURE 28.—A recently transplanted pecan orchard, showing the severe pruning that is appropriate in trees moved for the production of fruit rather than for their appearance

Orange trees may be moved in the same way. (Fig. 29.) All the leaves are taken off, and the pulling rope is fastened under the larger roots. The top is secured so that it will remain upright.

For larger orange trees a method is often employed (fig. 30) similar to that used for deciduous ornamental trees when moved with a ball of frozen earth. Here again the foliage is removed.

A more careful and therefore a safer method for moving orange trees is with a ball (fig. 31), the method employed with evergreen ornamental trees; but even here the leaves are removed, because a large proportion of the roots are cut, although the tree has been given a period of preparatory root pruning such as that recommended for ornamental plants.

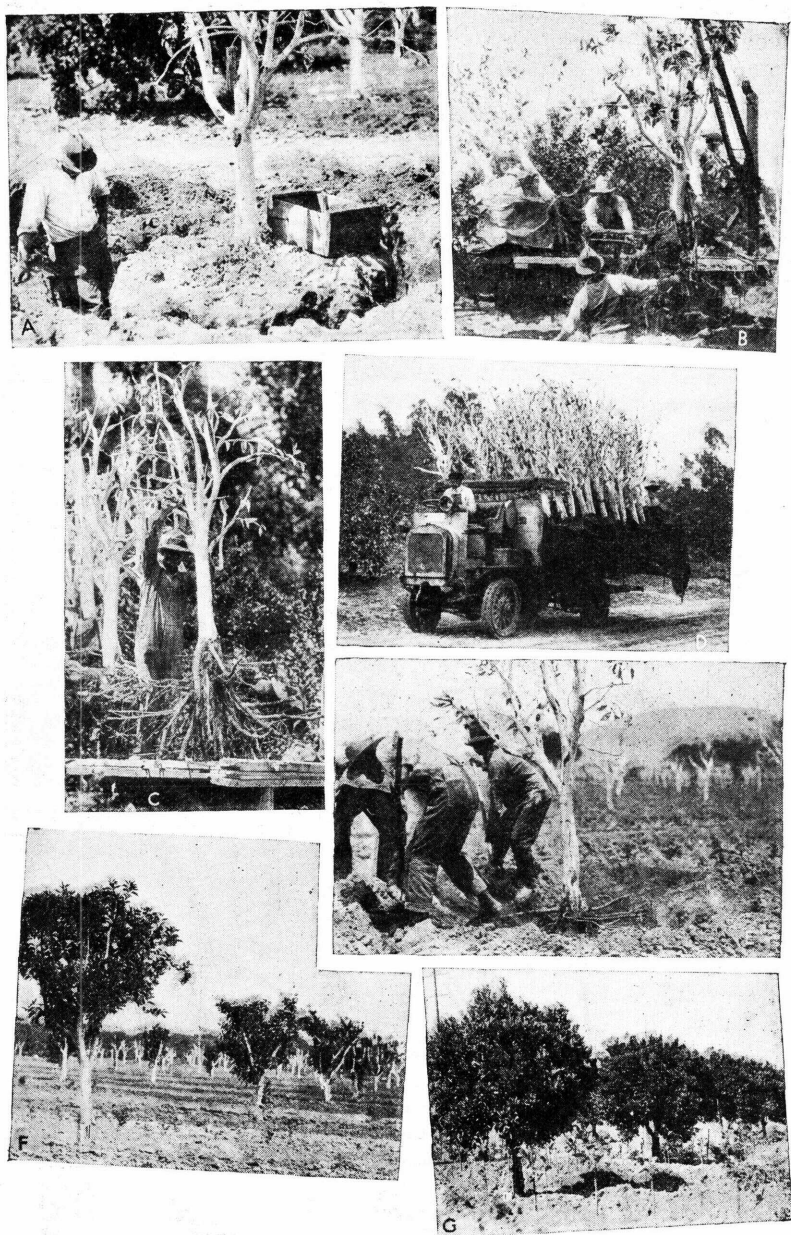


FIGURE 29.—Transplanting 6-year-old orange trees without a ball: A, First a trench is dug about the tree and then the soil is carefully worked out with a pick, so as not to injure the roots; B, loading the tree (note how the roots of the loaded trees are covered with canvas); C, a good root system; D, a load of trees with the roots well protected; E, planting at the same depth it was previously growing; F, as the trees looked in October, six months after transplanting; G, as they looked three years later

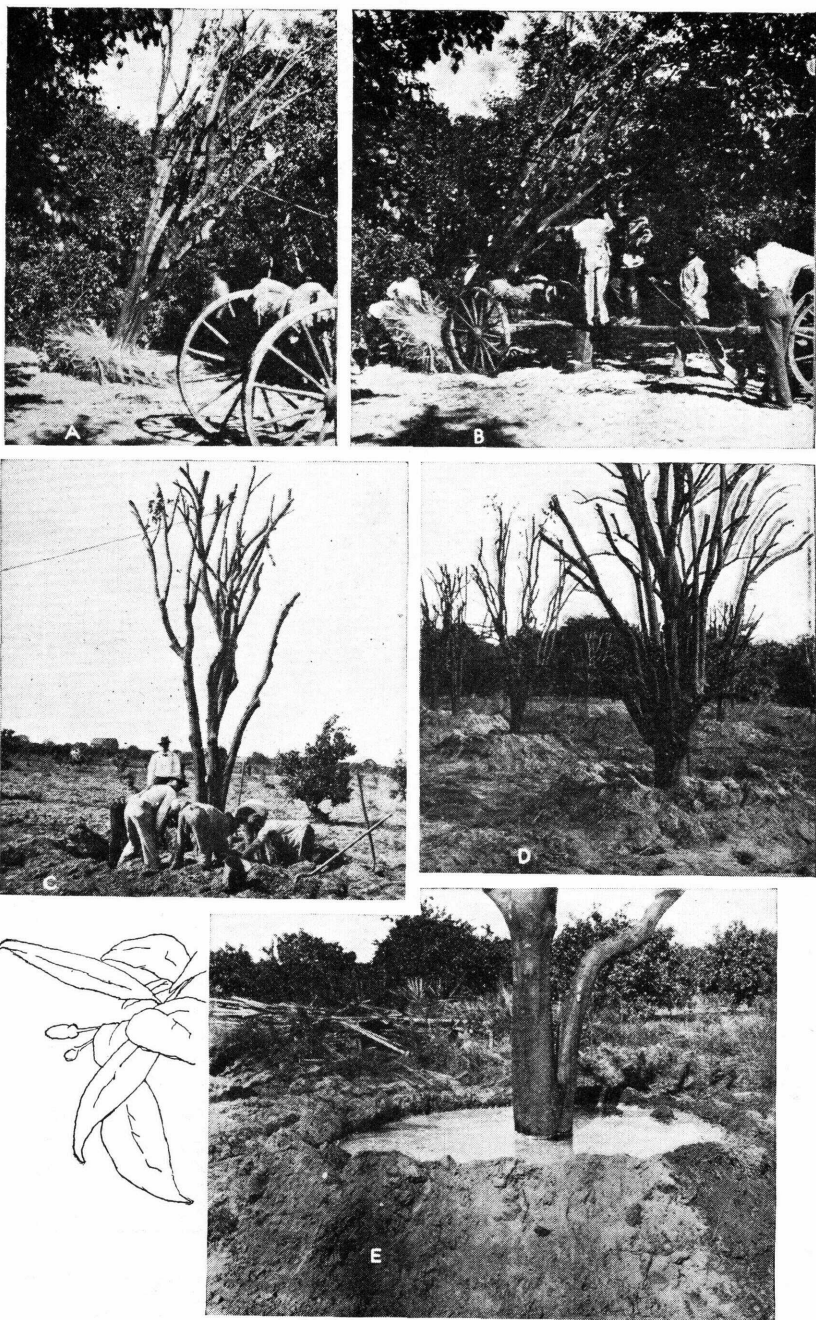


FIGURE 30.—Moving 20-year-old orange trees: A, Pulling the tree out of the hole after digging; B, placing it on the specially prepared wagon with a high padded bolster and a long reach; C, working soil in about the roots, the tree being at the same depth it previously grew; D, the set trees, with wells for watering; E, one of the watering wells filled

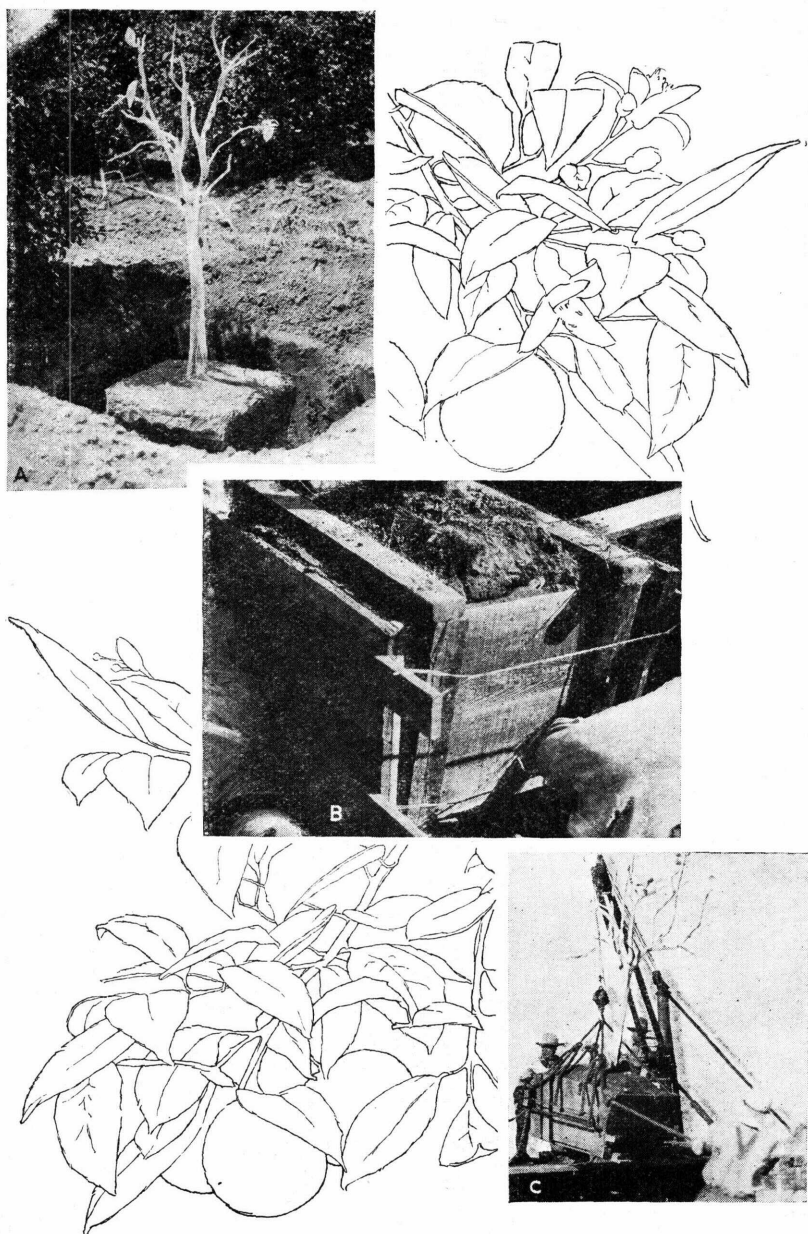


FIGURE 31.—Moving a 6-year-old orange tree with a ball: A, Preparing it to be moved; B, the supporting framework about the ball; C, handling the boxed tree

U. S. GOVERNMENT PRINTING OFFICE: 1929